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## MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF VASSAR COLLEGE

### XXII. THE EFFECT OF THE INTERVAL BETWEEN REPETITIONS ON THE SPEED OF LEARNING A SERIES OF MOVEMENTS.

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By MILDRED BROWNING, DOROTHY E. BROWN, and M. F. WASHBURN

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The fact was discovered by Ebbinghaus and thoroughly established by Jost that verbal material is learned with fewer repetitions if an interval is allowed to elapse between successive repetitions; if, that is, the repetitions are 'distributed' rather than crowded together. Now such a process of learning series of words or nonsense syllables involves two factors which may or may not obey the same laws. One factor is the establishment of associative dispositions, whereby one member of the series recalls the idea of other members. The other factor is the establishment of a habit of movement on the part of the articulatory muscles. These factors may be briefly called the associative and the motor factors in learning, and one of the most fundamental problems in the psychology of learning concerns their mutual relations.

In the present study the intention was to set a learning task in which the motor factor should play a larger rôle as compared with the associative factor than is the case in the learning of verbal material, and to see whether the law of distributed repetitions held good for such a task. If we wish to acquire a habit of movement involving the larger muscles of the body, shall we do better if we go through the movement a number of times in immediate succession, or if we allow an interval between performances?

Our problem was constructed as follows. On a sheet of cardboard a rectangle was drawn about thirty inches long by eighteen inches high. This rectangle was divided into eight compartments by lines drawn upon it, four compartments in the upper row and four in the lower row. Each compartment had a single letter printed in it, differing from the letters in the other compartments. The cardboard thus prepared was laid upon a table before the observer, whose eyes were closed. A pack of cards was placed in her hand. This pack was composed of cards, each one carrying a letter corresponding to one of the eight letters of the cardboard diagram. There were sixteen cards in the pack, hence, each letter appeared on two cards. The cards were numbered on the back. The observer, always with eyes closed, sat holding the pack, her hands above a mark on the table against which the center of the diagram rested. The experimenter took hold of her right wrist, and moved her right hand, to the time of a metronome, in such a way as to sort out the pack of cards correctly on the diagram, putting each card in the compartment bearing the letter which corresponded to the letter on the card. After each movement the observer's hand was brought back

to the mark in front of the center of the diagram. Thus the observer's hand was guided by the experimenter through a series of sixteen movements. The exact sequence of these movements had been carefully planned and was indicated by the numbers on the back of the cards, while the letters on the front guided the experimenter in the sorting. The observer, of course, keeping her eyes closed, knew nothing of letters or numbers; she simply felt herself being put through a series of movements, and formed some visual images of the position of her hand. She was now caused to go through this same performance repeatedly until she could sort the cards correctly without having the experimenter guide her at all. The experimenter, while still keeping her hand on the observer's wrist, gradually lessened the amount of her control as the observer came to 'know' the movements, until finally a correct sorting was made without contact from the experimenter. A record was kept of the number of repetitions required before this point in the learning was reached.

Each observer learned two such series of sixteen movements. With one series, the repetitions followed immediately one upon another without interval. To enable the repetitions to be made in such rapid succession, thirty packs of cards, exactly similar in arrangement, were provided, so that a fresh pack was put into the observer's hand as soon as she had finished a sorting, the experimenter merely sweeping the pack previously used from the board without stopping to rearrange it. The movement series was always learned in fewer than thirty sortings. A second series was learned with the repetitions at intervals of one minute. This allowed time for the experimenter to pick up and rearrange the cards between sortings. During the one-minute interval the observer's attention was distracted to prevent recall of the movements.

It is evident that one such series of sixteen movements may be a good deal easier to learn than another. If, for instance, the movements come in a sequence that can be easily visualized, the series will be readily learned. In 1911-1912 Miss Mildred Browning made under Professor Washburn's direction a set of experiments on the plan described above, using always the same series of movements, which we may call Series I, for the 'no interval' experiments, and another series, II, for the 'one minute interval' experiments. Great care was taken in the construction of these series to make them of equal difficulty. The results showed that the one minute interval produced decidedly quicker learning than the absence of interval. Since, however, it was always possible that Series II was easier than Series I, Miss Brown in 1912-1913 repeated the experiments, using two new series, A and B. No particular care was taken to make these two of equal difficulty, but in half the experiments Series A was the 'no interval' series and Series B the 'one minute interval' series, while in the other half the conditions were reversed. We also took precautions to eliminate the effect of practice, by making with half the observers experiments in the order 'no interval—one minute interval,' and with the other half experiments in the reverse order. There were twenty observers, of whom twelve had had considerable practice in psychological experimentation. Each observer learned two series. It will be seen that the special practice conditions were almost perfectly uniform, a condition which is not often realized in so small a number of experiments.

The results are stated in the following table. The letters in parenthesis after the numbers are the observers' initials. 'I' means that the series was the first one learned, 'II' that it was the second.

Series A.			
With Interval of 1'		Without Interval	
I.	II.	I.	II.
13(Bu)	5(T)	8(R)	8(B)
11(Q)	11(H)	4(C)	7(P)
4(Wi)	4(Su)	17(S)	6(Th)
5(Wa)	13(Ro)	11(Mc)	7(A)
5(E)	5(L)	6(Ba)	12(Sa)
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<i>Av. 7.6</i>	<i>Av. 7.6</i>	<i>Av. 9.2</i>	<i>Av. 8</i>

  

Series B.			
With Interval of 1'		Without Interval	
I.	II.	I.	II.
11(B)	19(R)	13(T)	19(Bu)
12(P)	3(C)	30(H)	24(Q)
11(Th)	7(S)	13(Su)	19(Wi)
13(A)	18(Mc)	28(Ro)	16(Wa)
11(Sa)	10(Ba)	26(L)	23(E)
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<i>Av. 11.6</i>	<i>Av. 11.4</i>	<i>Av. 22</i>	<i>Av. 20.2</i>

It appears from these results (1) that Series B was harder to learn than Series A, and (2) that an interval of one minute is more favorable to learning of this kind than no interval between repetitions. The average number of repetitions in all the 'no interval' experiments was 14.8; the average number in all the 'one minute interval' experiments was 9.6. It further appears (3) that the advantage of the one minute interval over no interval is more marked for the more difficult Series B. The difference between the averages for Series A was only one repetition, while for Series B it was 9.5 repetitions. While there was a good deal of variation in the results from individuals, it seems (4) that on the whole fewer rather than more repetitions were needed to learn a series when another series had been learned just before. The average number of repetitions tends to be a little smaller when the series is the second one learned. This indicates that practice was stronger than any tendency to interference of the older habit with the newer one.

Of course the learning of such series of movements involves both associative and motor factors. In the learning of the easy Series A, particularly, our observers reported that visual imagery helped them. It would not be proper to say that while Jost's experiments proved the value of distributed repetitions in the formation of associative dispositions, ours suggest a similar law for the formation of habits of movement. Jost's material involved motor as well as associative processes and ours involved associative as well as motor processes. We can, however, claim to have shown the probability that a certain degree of distribution of repetitions is favorable to learning in a case where the motor habits are not habits of articulation. And since any habit of movement would involve both associative and motor factors, we may say that there are indications of the validity of the law of distributed repetitions for habit formation in general. The significance of the fact that the advantage of the interval is less marked in the case of the easier series is doubtful. An easy series of sixteen movements, such as the one used here, involves in

its learning a good deal of visualization. The pattern of the movements is acquired and held, at least for the easiest parts of the series, as a whole simultaneously present in consciousness. Succession in time, on the other hand, is the special characteristic of processes with a strong motor element. It is possible that the law of distributed repetitions is a motor rather than a purely associative law, and that its validity in the learning of verbal material is due to the motor or articulatory factors in such learning.

### XXIII. A SUGGESTED COEFFICIENT OF AFFECTIVE SENSITIVENESS

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By HELEN CLARK, NEIDA QUACKENBUSH, and M. F. WASHBURN

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It is a curious fact that in experimental studies of individual psychology no attention, so far as we are aware, has been paid to the characteristic which we shall call affective sensitiveness. By this term we mean a tendency to strong affective reactions, whether of pleasantness or unpleasantness. Evidently affective sensitiveness may be general or special. If it is general, and marked, the individual possessing it will tend to strong likes and dislikes whatever the nature of the material presented for affective reaction. If it is special, he will show sensitiveness to one kind of material and relative indifference to another kind. Hitherto, the only consideration has been whether an individual liked one kind of material and disliked another: our problem is to study his tendency to be strongly affected, in either direction, by one kind and to be left indifferent by another.

In attempting to find a means of measuring this character of affective sensitiveness, we proceeded in the following way. Forty pieces 2.9 cm. square of colored paper, chosen at random from the series of Bradley colors, were numbered on the back. A series of forty nonsense syllables, each composed of an initial vowel and a final consonant, was prepared and each syllable was numbered. The observer was then given the following instructions: "You will be shown successively five colors; then you will have pronounced to you five nonsense syllables; then you will be shown five colors, and so on until you have seen forty colors and heard forty syllables. As you look at each color, you are to express your judgment of its pleasantness or unpleasantness by speaking one of the numbers from 1 to 7, 1 meaning very unpleasant, 2 moderately unpleasant, 3 slightly unpleasant, 4 indifferent, 5 slightly pleasant, 6 moderately pleasant, 7 very pleasant. As you hear each syllable pronounced, you are to judge its pleasantness or unpleasantness in the same way. You will be given a 'Ready' signal before each color is shown and before each syllable is pronounced. Your eyes are to be closed except when you hear the signal 'Now,' when you are to open them and look at a color."

The colors were laid one at a time on a sheet of white paper on the table before the observer, who reported her judgment at once. The syllables were pronounced with as nearly as possible the same force and distinctness. The same order of colors and syllables was always followed. At the end of an entire series free introspective comments were made by the observer.